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Local History

The Laguna Limekilns: Bonny Doon

By
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“Lime Light”

The purpose of this informal group is to study, understand, and teach the history of the lime industry in the Santa Cruz Mountains. It is hoped that by focusing on the technical aspects of individual kiln sites, a more complete story of the evolution of this industry will result.

We also promote the preservation of these valuable artifacts of our heritage, through restoration and maintenance, to be utilized as "outdoor museums."

Persons with primary or secondary source material; archives, letters, business records, diaries, and photographs; or differing opinions on this (or any other limekiln site) are encouraged to contact "Lime Light."

The author is a member of the Society for Industrial Archeology and the International Brick Collectors Association (member numbers SIA 2054-R and IBCA 788).

Acknowledgements

In 1975 little Joey Mullen led me to his "castle" across from where he lived on Ice Cream Grade. He didn't know what this structure was really used for, nor did I, but this started my probing into the past!

I would especially like to put Mike Luther in the limelight! Our mutual interest becomes synergistic when exploring and photographing together, and many of the concepts and interpretations presented here were generated "in situ." Mike has meticulously surveyed these kilns, and again I feel fortunate to be able to present his artistic rendering. I also appreciate his patient and thorough editing, and helpful suggestions.

Thanks to Ernest Wildhagen for sharing his memories of his walk down Ice Cream Grade in 1912! To Nancy Andreasen for saving and sharing her history class project, to Jeff Thomson for sharing his research and altimeter, and to Ken Jensen (who started it all) for his interest and support.

Gratitude to Mary Crouser, park ranger, for her assistance in making this report a reality, and for her patience!

And, again, to all those; past, present, and future who suffer from "lyme disease."

Bob Piwarzyk, Bonny Doon, February 22, 1996

Summary

The lime industry of the Santa Cruz Mountains employed about 200 men at a time when the city of Santa Cruz had a population of 800 persons! Later, about 25 men worked by hand at the Laguna limekilns quarrying, cutting fuel, making barrels, loading limestone, burning, and unloading and packing lime. The industry was, and continues to be, an important part of the county.

This site was remote, and shipping heavy barrels filled with lime five, steep miles to the railhead in Felton was hard and no doubt costly. This may be the reason the operation closed down after only about a decade, or perhaps it was due to the small deposits not being economical, or the lack of wood to fuel the kilns, or the danger to public traffic on Ice Cream Grade. In any event, its short life makes it easier to interpret the site, as the very nature of long-term quarrying can destroy any historical evidence as the quarry expands. It is the most concentrated, yet interesting, diversified site to be found, and offers an excellent opportunity to study the effects of quarrying and logging for fuel on the environment and the recovering ecology.

The story of these kilns has been synthesized from data collected and observations made over the last twenty years. Two and three foot narrow gauge tramways, an aerial tramway, and many small quarries make up the site. The kilns are the first to reveal firebrick floors in the fire chambers. Fourteen named firebricks were found on the site. All but two were probably imported from Scotland, England, and Belgium --- and that one had never been reported before!

Delightful stories abound on how "Ice Cream Grade" got its name, but for the first time the eponym for "Adams Road," its precursor, is identified as the Reverend Phelps R. Adams, assemblyman from Bonny Doon in 1893.

Many limekilns described in the historical record have already been destroyed. The Laguna kilns, quarry, tailings, and access ramps are overgrown. Several small trees grow in, on, and around the kilns, which are recommended for removal, but otherwise the kilns are in excellent condition. However, the lintel stone over one arch has failed and may result in eventual collapse of the front wall of the right kiln, which is already slightly bowed.

The Laguna kilns are an asset to the community and every effort should be made for their protection, restoration, and interpretation. More research is needed to establish the closure date and reason, and to date the tramway rails and pulley found on the site. Every effort should be taken to designate this historical industrial site with a California archeological inventory number, and to place it on the national register, as steps leading to grant funding for further research and restoration.

Purpose

The purpose of this report is to compile an historical background and a site description of the limekilns on Ice Cream Grade at Laguna Creek in order to educate the citizens of Santa Cruz and Bonny Doon as to the value of this site; to prepare a plan for maintaining, and preserving these kilns; and to propose an interpretive program for the most effective utilization of the site.

This report was commissioned by the Santa Cruz City Water Department. The site is on their watershed property. Portions of a previous report, "The Limekilns of the Pogonip," have been repeated, revised or expanded to make this a separate, complete document.

Site Location

The Laguna limekilns and quarries are located in Santa Cruz County, in the Santa Cruz Mountains, in Bonny Doon, California, approximately 5 road miles west of Felton. The site is within the southeast quarter of section 13 of township 10 S, range 3 W; and the western half of section 18 of township 10 S, range 2W. The site is from 1450' to 1600' elevation on the southwestern slope of Ben Lomond Mountain, where Ice Cream Grade crosses Laguna Creek. Santa Cruz County Surveyor bench mark 361 indicates an elevation of 1658.13 feet on Ice Cream Grade above the kilns. There is excellent agreement with this bench mark, the topographic lines on the USGS Davenport quadrangle map, and the site survey.

Unrecorded map A56-13 of Arnold Baldwin (undated, but known to be before 1938) for the lands of McLaughlin & Holmes Lime Company notes the quarter section corner on the eastern boundary of section 13, township T.10.S.R.3.W. as follows:

> 1" iron pipe for 1/4 sec. cor. (as per U.S. Deputy Freeman's returns) 8" T.O. N 360 W 10. 36" yellow fir (U.S. Deputy Craven's survey) S 220 W 36.73. 24" R.W. stump 1/4 s. cor by U.S. Deputy Foreman south 378.34 and east 48.36 (see Freeman's returns)

T.O. and R.W. indicate tan oak and redwood. Distances are in feet. This iron pipe and the witness trees were also surveyed by Tom Williams of Bowman & Williams of Santa Cruz in the 1940s, and was observed by the author in 1982 after flood waters washed away a log jam. The pipe is in the creek bed, downstream of the culvert under Ice Cream Grade, in the western channel of Laguna Creek (just downstream of the fork in the creek) and is currently buried again under debris.

This industrial site has never been designated with a California Archeological Inventory Number (CA-SCr-XXX) according to Cabrillo College records.

Site, sections, townships, bench mark, and ¼ section corner locations are shown on the maps and site plan in the appendix. [Not included here.]

Site Description

Uplifting and canyon erosion of the coastal range has exposed outcroppings of limestone, metamorphosed sandstone, and quartzite in the Laguna Creek watershed. Rainfall is adequate to support a mixed evergreen forest of redwood, fir, madrone, and tan oak, thus providing a source of fuel for burning the limestone. The site is divided north to south by Laguna Creek, and east to west by an unnamed intermittent creek. Downstream, Mahan Gulch follows Ice Cream Grade out of the canyon to the west. Limestone occurs on both sides of these ravines, from the creek beds to the ridgelines above. Ice Cream Grade, which served the kilns, hairpins through the narrow area upstream of the site to cross Laguna Creek. Within the hairpin lies one of the few small, wide alluvial flats to be found on Laguna Creek which generally flows through a narrow, steep-sloped canyon. It will be helpful to refer to the maps, site plan, drawings, and photographs in the appendix. [Not included on this site.]

On the east side of Laguna Creek, downstream of Ice Cream Grade, are two hillside limekilns. These side-by-side, pot kilns ("left kiln" and "right kiln") are constructed of large blocks of limestone from the adjacent quarry. They are graced with a carpet of algae, lichens, mosses, ferns, and occasional mushroom. A second growth stand of redwoods are growing in front of the kilns but do not seem to have any adverse effect. These trees block out the sunlight and maintain dampness in the area.

The floors of the large quarries to the south (downstream) are approximately 30' and 80' above the kiln floors. Quarry tailings were dumped on the west-facing slope on Laguna Creek below these two large pits. Other smaller quarry pits are located on the ridgeline above these large quarries. There are also pits upstream of the site on the unnamed creek to the east. The upper quarry has a section of two-foot gauge rails protruding from the limestone rubble. The lower quarry has a grade cut for a tramway and a bridge crossing to the kilns.

A large cast iron 6 ½' diameter pulley is located approximately 85' above the top of the kilns. This sits on an earthen platform retained with a 6' stone wall. Anchor cables and a small quarry pit are uphill of the pulley. A bearing 90 degrees to the center of the wall sights down to the two A-frame structures found at the top of the left kiln. Although no cable or ore cars were found, it seems reasonable that an aerial tramway was used at some point of the operation.

Rails, ties, and spikes for a three-foot gauge tramway were found buried beneath the loop road along the top of the kilns. It is possible that the larger gauge tramway was used only during construction of the kilns to bring larger, heavier rock for the kiln walls to the site. The rails extend south beyond the right kiln and curve to the east up the side ravine.

The area has several logging and skid roads radiating out from the kiln site. One skid road is still in place upstream of the waterfall on the east fork of the creek. One road extended through the upper canyon all the way to Atherly Way. Part of this is now the lower part of the driveway at 1373 Ice Cream Grade. Notches for spring boards are seen in most of the remaining virgin redwood stumps. The canyon is entirely second growth. Part of the canyon may have been logged for lumber prior to the Holmes Lime Company logging for fuel for the kilns.

Judging from the sizes of the kilns and the quarries, not too many loads were fired. Kiln waste was dumped on both sides of Laguna Creek from the bridge to the confluence of the creeks and was used as fill to build up the work areas. Greater use of this site would have produced more waste. There is no kiln waste to be seen downstream of the site. Action of streamflow great enough to carry such waste would most likely cause it to crumble.

An access ramp from the entry road from the north to the top of the kilns circles around to the south and back down to kiln floor level. This was a turn-a-round loop for the dead-end road that served the site. It would seem that wagons would have adequate room to turn around in front of the kilns, but this area would normally have had cords of wood stacked up for fuel, and empty or loaded barrels. A loop was certainly easier than backing up a horse-drawn wagon. Also ore brought to the site by wagon could be unloaded into the top of the kiln.

The Bonny Doon planning area map, dated 24 May 94, indicates that the current land use is "public facility," as it is Santa Cruz City Water Department watershed property. It is also shown within the coastal zone. The natural & cultural resources protection, production and extraction maps indicate that it is scenic, riparian corridor, timber, ground water recharge, and water supply watershed land.

The kilns, quarries, tramways, pulley and A-frame are discussed in more detail in separate sections of the report. The site plans, plan view and section, are presented in appendix B. [Not included here.]

Geology

The best general description of the geology of the Santa Cruz Mountains can be found in the introduction to John Hunter Thomas' "Flora of the Santa Cruz Mountains." It was written by Earl E. Brabb, School of Mineral Sciences, Stanford University. Thomas included this on the premise that the diverse plant communities found in these mountains could be described by their habitat --- climate and soil --and that geology was a useful tool for understanding this. It is written for the novice, and well worth reading. More technical information is available, but only a limited amount is presented here to provide some background.

The geology of Ben Lomond Mountain is very complex and Laguna Canyon seems to have all the components concentrated into a small area. There are several kinds of limestone to be found here, all of which are metamorphic. The fractured outcrop on Laguna Creek upstream of Ice Cream Grade is pure marble with large white crystals. This is low grade marble, but limestone in the Santa Cruz mountains is often classified as marble as it just passes the hardness test. Ore of this quality does not appear to be abundant in the nearby quarries. There is a waterfall upstream that is caused by the slow erosive rate as the creek crosses a vein of this type of limestone. On the west side of the creek, uphill of Ice Cream Grade, the limestone is grey and more granular. When broken open, it smells heavily of sulphur and has dark, parallel ribbons running through it. This type of fetid limestone is called "stinkstein." The quarries have a solid

grey, granular ore which is occasionally coated with flowstone which forms in the manner of stalagtites in caves. This is most likely due to ground water flowing through the many fractures found in these deposits.

Gold was reported as having been found in Laguna Creek in the late 1800s. As recently as 1952, small quantities of very fine flakes were found using electronic metal detectors. Iron pyrite --- "fool's gold" --- found in abundance in the creek is easily confused with this "color."

On the following pages a detailed map of the limestone quarries, pits, and outcroppings located in the vicinity of the Laguna limekilns [not included here], and a description of the deposits is presented. This description states that no quarry was identified, which may not be unreasonable as this author only located the quarries five years after first visiting the kilns!

Appendix B has further information on the geology of the upper canyon. The composite map entitled "The Limekilns and Roads of Bonny Doon" shows the locations of limestone deposits in the lower canyon, upstream of Smith Grade, as surveyed by the Santa Cruz Portland Cement Company in 1911. [Not included here.]

> "Ice Cream Grade deposits. Location: SE ¼ sec. 13, T. 10 S., R 3 W. and W ¼ sec. 18, T. 10 S., R. 2 W., M.D., 3 ½ miles west of Felton; Ben Lomond 15 minute quadrangle. Ownership: not determined (1963).
>
> Several small limestone deposits are exposed along Ice Cream Grade road in the vicinity of Laguna Creek. The limestone is crystalline and forms well-defined massive beds interlayered with schist and quartzite. These small deposits are somewhat impure and appear to be of little or no economic interest.
>
> Two old stone limekilns, situated on the east bank of Laguna Creek just south of the Ice Cream Grade road, testify to early efforts to develop limestone in the vicinity. The kilns are identical; each measures 15 feet by 21 feet on the inside, and both are completely open at the top (no stack). No limestone quarry was identified in the area, and there is evidence that only a little lime was burned. A quarry location and the general distribution of limestone outcrops is indicated by Branner 1 et al. (1909 map) and Leo 2 (1967, p. 30)." 3

1 Branner, J. C., Newsome, J. F., and Arnold, R. 1909. Description of Santa Cruz quadrangle, California: U. S. Geological Survey Geologic Atlas, Santa Cruz Folio, no. 163, 11 p.

2 Leo, G. W. 1967. The plutonic and metamorphic rocks of the Ben Lomond Mountain area, Santa Cruz County, California, in Short contributions to California geology: California Division of Mines and Geology Special Report 91, pp. 27-42.

3 Hart, Earl W., Limestone, Dolomite, and Shell Resources of the Coast Range Province, California; Bulletin 197; California Division of Mines and Geology, 1978, p. 48.

Kiln Descriptions

The Laguna limekilns are two, open top, side-by-side, top loading pot kilns that were built into the hillside such that the back and side walls are supported by the earth. All walls are made of locally quarried and faced limestone, and are rubble filled with mortar. The front walls have two archways in each kiln. Each archway provides access to a fire chamber (also called the "tunnel" or "arch"), which is an arched tunnel constructed from the limestone ore as it is loaded into the kiln. This tunnel extends from the front wall to the back wall and straddles the fire chamber floor.

The front walls are supported by three integral buttresses, one on each side of the kiln face and one in the center. There is no evidence that the work area between these buttresses had a roof, as is seen at other sites (UCSC and Fall Creek). The archways are constructed with flat lintel stones spanning the width of the opening. There is no evidence that the fire chamber had doors. Impressions in extant mortar indicate that this passage was lined with firebrick which was arched, and that the interior walls of the kilns were lined with firebrick. The floors of the kilns had fire chamber floors, which extended from the front wall to the back wall, and were also made of firebrick. Most of this brick was imported from Europe and is discussed under "Firebricks at the Laguna Limekilns." Scale drawings of the kilns are presented in appendix B. [Not included here.]

Generally, the Laguna limekilns are in excellent condition. A few small trees are growing on, in, and in front of the kilns. Damage seems to be minimal from the roots. The front wall of the right kiln bows out approximately 8" at the top, is missing the top 12" of rocks, and has an offset of 2" with the center buttress. The lintel stone of the right-hand arch has cracked both horizontally and vertically. The outer lower piece has fallen. It is hard to determine if this failure has caused the wall to bow or if the wall failure caused the lintel to fail. Small cracks in the buttress walls are most likely due to settling, or seismic forces, however the kilns have not changed any in the 20 years observed by the author.

The top row of rocks around the inside perimeter of the kiln was usually made with flat rocks, and was called a "curb," or "cap." All the capstones are missing from both kilns. It seems likely that they were salvaged for another use as only a few are found in the rubble inside the kilns.

The floors of the limekilns are covered with rubble up to 1' deep, which contains chunks of firebrick, cans and broken bottles, and other small pieces of trash. When surveying the kilns, an area was cleared in order to determine a datum elevation. It was discovered that the floor of the fire chamber was constructed of firebrick! This feature would help reflect the heat from the fire back into the kiln, and would make it easier to remove ashes from the fire chamber. This is the first indication that this was ever done. No other site has any evidence that a floor exists. If there are any others, they are covered with rubble.

The brick are laid on edge, in what is either refractory mortar or fireclay, with seven rows extending lengthwise from front to back, and an edge row laid perpendicular to these on each side, for a total width of three feet. About three feet of brick have been removed from in front

of each arch on the left kiln. The firebrick floor extends to the back wall but the last three bricks are stepped up (see photograph [not included here]). The right kiln was only probed enough to confirm that it also has a floor on the left fire chamber. No floor was found at the right arch.

At the base of the left wall of the left kiln, an impression of a firebrick lying flat and perpendicular to the wall was uncovered. The end of this brick was 16" out from the limestone wall, which would locate the surface of the firebrick lining. The space in between had been filled with chunks of brick pieces embedded in a red clay. It is deduced that after the lining was removed, the inner layer of brick pieces peeled off, leaving some red clay adhered to the limestone walls. The bricks lining the back wall were set against the limestone wall with only the red clay used as a filler. The bricks lining the front wall were set in cement mortar, which is extant with chunks of brick as a filler and impressions of brick ends. Therefore, dimensions as measured to the limestone walls must be reduced by approximately 18" (the length of two 9" brick) front to back, and approximately 32" (the length of two 9" brick plus filler) side to side, to deduce the interior dimensions of the lined kiln.

The rubble on the floors of these kilns is higher in the center. There are ridges, extending front to back, on both sides of each fire chamber floor. Possibly this is due to the manner in which the fire chamber arches were built as the kiln was loaded. With use, the quicklime crumbles and accumulates on the floor, where it naturally hydrates and hardens. Redwood roots, probably from the stand in front of the kilns, lie on top of this hard-packed floor. Their removal would not affect the trees.

The left kiln face and buttress walls have been pointed up with Portland cement mortar. Larger spaces were chinked with firebrick in several places. The right kiln has very little pointing remaining, if it was ever there. Overall, the left kiln is in better condition. It is possible that use of the right kiln was discontinued, due to the failed wall and lintel, before the left kiln was abandoned.

The right kiln has several items worth noting. The lintel stone in the right arch was cracked through a hole drilled into the stone. This is the only tool mark to be seen on the site, as drilling is not in evidence at these quarries. Holes are found in the large rocks in the UCSC kilns. They provided a means of lifting and moving them from the quarry and into position with block and tackle rigging. This 1" diameter hole is about 4" deep and has a snub nose with an irregular surface such as would be made by a star drill.

There is a solid metal rod at the left hand base of the left arch, whose purpose is not known. It is 1" diameter and 14" long, and could be a drill bit (although the end seems to be broken and not hammered) or a rigging bar that got stuck in a hole and could not be removed. The rod protrudes from the wall between two blocks and whether it is embedded in a hole, or not, can't be determined. Possibly the rod was part of a bracket or pivot for mounting a kiln door, but there are none on the other arches.

The following two pages summarize each of the Laguna limekilns.

Laguna Limekilns - "Left Kiln"

Looking East

Date: H.T. Holmes Lime Company's "new kilns." Construction noted December, 1899. Date closed unknown, maybe ca. 1912.

Description: Hillside, top loading pot kiln. Walls are mixed shaped and unshaped limestone. Interior randomly laid with mortar. Front wall of nine lifts, and buttresses of seven lifts are dressed, laid with lime mortar, and are pointed-up with Portland concrete cement. These walls are rubble-filled with mortar. Some coving at top. Interior corners have small, varied radii. Has fire chamber floors.

Number of arches: Two

Dimensions: (Heights measured from original kiln floor.)

> **Interior**: 18' 10" wide x 15' 10" high x 13' 9" deep
> (firebrick lining thickness not included; see text.)
> **Front wall thickness**: 5'
> **Arches**: 3' 3" wide (avg.) x 6' 0" high

Firebricks: Inside front wall has mortar with brick filler. Impressions indicate that kiln walls were lined with brick laid horizontal, face up, ends to wall. Thirteen named brick show that most were imported from Scotland, England, and Belgium. Regular, arch, and wedge brick were found. Fire chamber floors are made of firebrick laid on edge.

Condition: This kiln is in excellent condition, except for the soft, crumbling red mortar in the interior walls. All of the wall capstones are missing and the kiln floor has about 1' of rubble. Small (4-6" diameter) trees are growing in and on the kiln. The left hand buttress has a minor crack running through the wall.

Mitigation: Remove small trees from kiln.

Laguna Limekilns - "Right Kiln"

Looking East

Date: H.T. Holmes Lime Company's "new kilns-" construction noted December, 1899. Date closed unknown, maybe ca. 1912.

Description: Hillside, top loading pot kiln. Walls are mixed shaped and unshaped limestone. Interior randomly laid with mortar. Front wall of nine lifts, and buttresses of seven lifts are dressed, laid with lime mortar, and are rubble filled with mortar. These walls lack pointing-up mortar. Some coving at top. Interior corners have small, varied radii.

Number of arches: Two

Dimensions: (Heights measured from original kiln floor.)
Interior: 19' 3" wide x 16' 10" high x 14' 6" deep
(firebrick lining thickness not included; see text.)
Front wall thickness: 5' 2"
Arches: Left arch - 3' 3"wide x 5' 9" high
Right arch - 3' 6" wide x 5' 6" high

Firebricks: Inside side walls have mortar with brick filler at the base. Thirteen named brick show that most were imported from Scotland, England, and Belgium. Regular, arch, and wedge brick were found. May be fire chamber floors.

Condition: Front wall bowed out 8 inches at top. The right arch lintel stone is cracked and a piece is missing. All of the wall capstones are missing and the kiln floor has about 1' of rubble. Three stones missing from center buttress face. Small (6-8" diameter) trees are growing in, on, and in front of the kiln.

Mitigation: Remove small trees from kiln. Replace stones and point-up front walls. Brace lintel and front walls.

Firebricks at the Laguna Limekilns

Some brick pieces can be found in the remaining lining of both kilns, and in the rubble around the kilns. Brick has also been found along the creek banks, as the flat area in front of the kilns was built up using kiln waste for fill.

The remaining lining in the left kiln has only chunks of brick embedded in mortar. However, there are impressions of brick in the wall mortar which indicate that the bricks in the outer layer of the lining have been scavenged. Fire chamber floors made from "Calder" firebrick were uncovered in the left kiln. Otherwise only two whole brick were found. It has been possible to determine names by fitting overlapping pieces together and by recognizing names found on bricks at other sites.

The following bricks were found at the site from October of 1975 to March of 1996:

Calder
Carr
Cowen
Foster
LAPBCo / * * *
Ls Escoyez / Tertre / Belgique

Pacific (several found with thumb prints)
Pacific (wedge shaped, only one found)
Patent / R Brown & Son / Paisley (no period)
Patent / R.Brown & Son Ltd / Paisley
Ramsay
Ravens / WBI & Co
RBC
Snowball (two found with the "b" upside down)
Tcarr
Tcarr (arch shaped, only one found)

Note: / denotes the beginning of a new line on the brick

Also found were several pieces of "arch" brick (keystone shaped), without any name, and one common red brick with a vitrified end (black and glazed).

Except for the LAPBCo / * * * brick (Los Angeles Pressed Brick Company), and the RBC (Richmond Brick Company?), these firebricks were most likely all imported from Europe. The discussion, presented under "Firebricks" in the interpretive section of this report, tells what is known about each brick. Adapted from "Bricks and Brickmaking," by Karl Gurcke, it is used with the author's permission.

Introduction

It comes naturally in many forms. It comes in shades of white, yellow, green, brown, red, grey, and blue. It comes from a myriad of ancient creatures broadcasting their skeletal remains on the ocean floors over many millenniums. It may even come from plants and algae, or bones. It has been called "the powder of civilization." It is lime!

In Santa Cruz, limestone ranges from marl to marble, from the pure white crystals of calcite to the "Ben Lomond blue." Along the ancient Ben Lomond fault, the quarries at Fall Creek and the Pogonip were called "blue cliff" and "blue rock." Traces of grey to blue graphite impart its color to these ores. All fossil traces of the life that created them were lost; dissolved under the pressure of miles of accumulated sediment. Then they were metamorphosed by the heat of large intrusions of fluid granite, called plutons. These penetrated the ancient layers of sea sediment and became the granite on Ben Lomond Mountain. But perhaps as much as ten miles of uplifted material had to erode away before either could be seen!

The seismic forces that caused the uplifting also laced the limestone with faults and fissures. Therefore it is difficult to quarry large building blocks, but smaller stones, marble facing, and crushed rock have been used locally in construction. However, it is the purity of the limestone found in the Santa Cruz Mountains that makes it so valuable. Any ore containing 50% or more of calcium carbonate can be considered limestone. Here it reaches 95 to 97% and can produce the highest grade of building lime.

This report is a continuation of the story of the lime industry in Santa Cruz County. Initially Ben Lomond Mountain was exploited at its southernmost end by the Spanish and the Mexican/Californians on a smaller scale, and then on a larger scale by the capitalist Yankees for export and profit. These earlier efforts demonstrated the viability of meeting the demand for building materials in the burgeoning state of California.

The industry expanded north out of the city and up the coast to Davenport on the west flank of the mountain, and up the San Lorenzo river valley to the east flank above Felton. The industry flowed over the mountain from Felton. The industry not only acquired vast land holdings for the quarries and kiln sites, it acquired forest land to provide wood to fuel the kilns. The industry competed with the saw mills. A story of land control and enterprise unfolded.

As the Laguna limekilns were a link to the industries of the valley and the coast, so they are now a link in "The Limekiln Trail." As shown on the map and key on the following two pages, this "trail" extends from Samuel Adams' kilns on Grey Whale Ranch and the four kiln sites on the UCSC campus; past the Kalkar quarry; past the Pogonip quarries and kilns; on to the Rincon, Holmes, Bennett, Bull, and Ixl kilns in Felton; and over the ridge line to the Laguna kilns on Ice Cream Grade.

More remains to be learned from the Laguna limekilns!

The Limekiln Trail

Key to remaining kiln sites on attached map [Not included here.]
(All kilns are pot kilns unless otherwise noted.)

Location	No. of Kilns	No. of Arches	Date/Owner
[1] Pogonip (old)	1*	unknown	Unknown/Mission?
Pogonip (south)	1	3	Unk/Brady or Reed?
Pogonip (north)	1*	4	Unk/Brady or Reed?
[2] UCSC (gate)	3	4 each	1851/Jordan & Davis 1864/Davis & Cowell (Cowell's lower kiln)
UCSC (gate) - oil, continuous?	1	2	Unk/Davis & Cowell
[3] UCSC (upper quarry)	1	6**	Unk/Brady or Reed?
[4] UCSC (bridge)	1	3	Unk/Brady or Reed?
[5] UCSC (Elfland)	1	unknown	Unknown/Mission?
[6] Grey Whale Ranch	3***	4 each	1858/Samuel Adams 1869/Davis & Cowell (Cowell's upper kiln)
[7] Rincon - patent**** - pot kilns	4* 3*	--- 4 each	1906/S.H. Cowell 1920/S.H. Cowell

Henry Cowell Redwoods State Park			
[8] Felton - pot kilns***** - Continuous	5* 2*	1 each? 2 each?	1876/Russell - Holmes 1881/Holmes Lime Co.
[9] Felton	1	3	1866/Thomas Bull(Bohl)
[10] Felton	1	3	1867/Eben Bennett & brother, Stanley
[11] Felton Fall creek State Park	3	4 each	1874/Ixl Lime Co.: to Isaac Blum, 1896 F.D. Seeyle, Moses Cerf, & A. Blockman 1900/Ixl Lime Co. (Henry Cowell)
Bonny Doon	2	unknown	1858/Andrew Glassell
Lone Star quarry (not on map)	2*	3 each	1867/Andrew Glassell, Grove Adams, B.F. Lee, & P. Fitzhugh 1869/Grove Adams
[12] Bonny Doon Ice Cream Grade	2	2	1899/Holmes Lime Co.
Lexington (not on map)	3	1 each	Unk/Jordan & Davis?

* Not reported by Jensen
** Jensen reported four arches
*** Jensen reported two kilns
**** Standard 34' continuous kilns
***** Four 500 barrel pot kilns and one 1,000 barrel pot kiln

Revised 14 March 1996

Historical Background

In California, lime production techniques arrived from at least three directions: from the north by the Russians, from the south by the Spanish, and from the east by the Americans. The Chinese from the west may have made small quantities out of sea shells. Early Santa Cruz was under the Spanish influence and then became Mexican territory. Before the revolt and statehood in 1850, Santa Cruz experienced a time of American influence when the Yankees penetrated into the social and economic structure of the Mexicans. They married, acquired land and began various businesses. One such enterprise was the large-scale production of lime.

Prior to this, lime was either made in pits or in small, single-pot kilns by burning various sources of calcium carbonate: limestone, marl, seashells (large ear-shells and perhaps abalone shells), and fossil seashells. The use of lime made from shell was recorded in ancient China (the Hsia dynasty of 2205 - 1766 BC.).

Seashell lime was used by the Russians at Fort Ross and by the Spanish at Monterey. The Russians used seashell lime in making soap. They probably also used it in making whitewash for their windmills and farm buildings, in "tawing" hides, and in making mortar (which they probably made since they made bricks). Kilns were also used by both to manufacture bricks from clay. The missions at Carmel and Santa Cruz had tile kilns, which were used to make floor and roof tiles.

The Russian industries are not as evident as the Spanish industries. However, their presence to the north played an important role in our history. Because they were there, and moving south, the Spanish made the decision to establish the missions, presidios, and pueblos, and occupy their claim to the north. The fact that the mission at Monterey (later moved to Carmel) was the second one founded, reflects the urgency of the situation.

The earliest record (in 1792) of lime making in California was by the historic visitor, Vancouver, who wrote of seeing lime being made in Yerba Buena (now San Francisco), and at Mission Carmel "from sea shells --- in great abundance on the shores; not having found as yet any calcareous earth that would answer this essential purpose." Duhaut-Cilly traveled the coast in the late 1820s and reported shell lime being made for the construction of the new mission church at Santa Barbara. Shells have also been observed in cement aqueduct pipes.

The mission church at Santa Cruz was built in 1793. Later reports said the bottom of the walls were constructed of lime rock and lime mortar, but recent findings show that the footings were made of mudstone and mud mortar. The upper part of the wall was made from adobe brick. Exterior walls were usually covered with lime or mud plaster and sealed with whitewash made from "milk lime." The Spanish may have already experienced our wet winters and may have already known that damp adobe wall foundations did not stand up in earthquakes very well!

Sometime after 1797, the mission of San Fernando near what is now Chatsworth, may have used a limekiln to make foundation cement which they called "mezcla." State historical marker #911 notes that this "calera" is the first evidence of European industry in the Los Angeles area. Calera is Spanish for "limestone quarry" or "limekiln."

The stone mission church at San Juan Capistrano was completed by 1806, only to be destroyed in the 1812 earthquake. The exposed hard-burned brick and mortar archways, and the vaulted ceiling of cement (or some would say concrete) withstood the weather many times longer than the ruined adobe structures did.

Lime use is also documented for missions San Buenaventura and San Diego. Missions San Antonio and San Gabriel also had vaulted "concrete" roofs. The Spanish were among the best stone masons in Europe, but California earthquakes added a new element and many of their structures were destroyed or badly damaged in 1812, and continue to be.

The mission economy primarily provided for the needs of the mission. At least that was the intent of Spain, as it was illegal to trade with foreign countries. But trading (actually smuggling)

was done with the Russians, the British, the French, the Americans, and others. Mention is made of exporting hides and tallow, and some wine, brandy, olive oil, and leather work. Lime was probably used in making soap and leather but is not mentioned as an export. But we know that lime was used, and that wherever lime was used a kiln was probably located nearby.

In San Francisco the Spanish were building their sixth mission, while the Americans were declaring their independence from England. In 1810 Mexico gained independence from Spain. By 1825 all twenty-one missions had been completed, the Monroe doctrine was in effect, and Mexico had its own emperor. Then in 1834, a new liberal Mexican government ordered that the missions be secularized. That same year saw a Russian from Kamchatka, Jose Bolcoff elected alcalde of Branciforte. By 1846 all missions were secularized except for three, which were sold. Enter the Yankees from the east!

The Americans brought with them a long history of lime manufacturing. Their countries of origin in Europe all made lime. Shell-lime was made by the Spanish at St. Augustine, Florida, and by the settlers at Jamestown, who used oyster shell dredged from a nearby estuary. In January of 1662, permission to burn lime was given by the town of providence, Rhode Island, to Thomas Hackelton. Production was noted at kilns in Maine, Vermont, Massachusetts, New York and Pennsylvania. Lyme, Connecticut, named for its lime industry, is now noted as the first place lyme disease was identified-in addition, many farmers on the east coast made their own lime, for sweetening the soil and other uses similar to the Russian and Spanish. The first settlers of Stone Valley, Pennsylvania, in Northumberland County, built a coal-fired kiln which is still used today! Sailing ships brought lime around Cape Horn from Pennsylvania to meet the demands of the booming new state.

The demand, market, limestone, and fuel were here. Capital was available. Labor was also available, as many men were unemployed from the gold fields. The redwoods were abundant and burned slow and steady with long, hot flames which were ideal for limekilns. The bay afforded the means of shipping the product to market by schooner.

Men like Albion P. Jordon and Isaac E. Davis led the way in 1851. Actually, they may have bought existing kilns operated by earlier Californios in the 1840s. Tradition says their first kilns were the ones now at the UCSC campus gate, but also that they built their kilns on Rancho Rincon land, although the campus gate is not within the rancho boundaries. Their first kilns may have been the ones in the Pogonip or the upper campus (see "The Limekilns of the Pogonip," by the author). In any event, an 1856 production report listed export of 19,331 barrels of lime valued at $57,993.00, or $3.00 / barrel!

Samuel Adams began producing lime one mile west of them in 1858. The industry expanded north out of the city and up the coast to Davenport on the west flank of the mountain, and up the San Lorenzo river valley to the east flank above Felton. The industry not only acquired vast land holdings for the quarries and kiln sites, it acquired forest land to provide wood to fuel the kilns. The industry did not always compete with the saw mills as sometimes the best timber was

used for lumber and barrel staves. "Wood" was used as fuel for the kilns. Sometimes the saw mill provided scrap wood.

In the same year, 1858, Andrew Glassell began operating limekilns in Bonny Doon uphill of William's Landing which is now Bonny Doon Beach. The coast road had been built but it was a long, tough haul to the wharves in Santa Cruz. Glassell loaded his lime at William's Landing by sliding it down a cable to the schooner below --- a very unsafe operation. Even with this handicap he took on partners from San Francisco in 1867 and expanded his operation.

The year 1867 also witnessed the start of two single-pot kilns a mile west of Felton by Eben Bennett and his brother Stanley, and by Thomas Bull (AKA Bohl). These men were friends, had side by side operations, and shipped their lime together from Felton to Santa Cruz. Transportation added to the cost of their product and they looked forward to the coming of the railroad to Felton. Construction was stalled for a few years by their competitor, Henry Cowell, who controlled the Rincon. Cowell went to court to deny the railroad a right-of-way, but in the meantime Bennett and Bull's transportation costs were higher, giving Cowell an advantage.

Meanwhile, Henry Cowell became partners with Davis when he bought Jordon's share of the business in 1864. Jordan was ill and died the following year. In 1869, they bought out Samuel Adams kilns, which were located where Grey Whale Ranch is today. Cowell had forced Adams to transport his lime down to Wilder Ranch by refusing him a shorter route across his property. They continued operating it as their "upper kilns" (the kilns that are now at the UCSC campus gate became the "lower kilns.") Cowell went on to be the sole owner when Davis died in 1888.

The Reese (also shown as Reis) brothers started the Santa Cruz Lime Company in Davenport and built a wharf at Davenport Landing in 1875. This was competition for the existing Davenport wharf. Jensen (refer to "bibliography" for Jensen, Koch, Clark, and Orlando) states that their kilns were 3 miles east of the wharf. The end of Thayer Road is exactly 3 miles from Davenport Landing, so the kilns said to have been buried west of Thayer Road could be these kilns!

Grove Adams, who was one of Glassell's partners, ended up the sole owner of that operation. He sold out in 1872 to two men who built a road to connect the limekilns with the wharf at Davenport so they could utilize that better, safer facility. No further mention is made of them, and not much is known about the later owner, George B. Jacobs, of the "Jacob lime kiln," other than these names appearing on a road petition. They ended up being designated "Cowell's old kilns." It is uncertain whether Cowell ever operated them. He bought out many operations which he closed down. His empire was becoming a monopoly.

The H.T. Holmes Lime Company

Thomas Bull (sometimes shown as Bohl) bought 450 acres in 1865 and began producing lime in 1866. The following year Eben Bennett bought 640 acres for $825 and built a kiln. In 1868 Bennett and Bull bought a small parcel (Jensen doesn't say where, but it was probably for storage near the wharf) and shipped their lime together the eight miles to Santa Cruz. They used a wagon and trailer with 6 mules to haul 100 barrels (about 10 tons of lime!) at a cost of 25 cents a barrel. The 1869 earthquake on the Hayward fault (sometimes also called the San Francisco earthquake) caused many of the new unreinforced brick buildings to collapse. These had replaced redwood structures, which were always burning down. But now brick and mortar had literally fallen out of favor. Production of lime from Santa Cruz took 9 years to regain pre-quake levels. After the railroad came to Felton in 1875, Bennett bought 200 more acres the following spring. Bull sold land and worked with a lime merchant from San Francisco, Henry Holms. They set up a new lime business in July, 1876, and soon thereafter Bull sold his share and retired from the lime business.

Holms then purchased 248 acres from the Bennett estate, plus the Bennett kiln for $600. This was the same year, 1876, that Eben Bennett died and that Thomas Bull put in a "patent kiln," a continuous burning kiln named "Monitor." Jensen uses the spelling Holms, but the name also appears as Holm, Holme, Homes, and Holmes. There are also references to "The H.T. Holmes Lime Company" existing in 1881, originally called "Russell and Holmes," perhaps because Russell ran the operation in Felton while Holmes marketed the product from San Francisco. Later, William Russell is listed as the superintendent at Felton, and W. Russell as a 1905 Bonny Doon property owner.

The mountain had enough ore to meet the demand, and in 1874 the IXL Lime Company was incorporated. San Francisco capital was invested in three large side-by-side kilns on the south fork of Fall Creek to the north of Bennett's kiln. This operation, along with Davis & Cowell's, and Holmes', became known as "the big three." By 1880, they produced 95% of the lime used in San Francisco and 50% of the lime used in the state! The 1890 annual report by the state mineralogist states that the Holmes Lime Company reported gross production in Santa Cruz County for the two years ending September 1, 1890, at 220,000 barrels of lime, and they still had adequate supplies of redwood. A later report refers to "The W.T. Holmes Lime Company." This may be an error or Henry died and a relative took over.

Cowell became the sole owner of "Davis & Cowell" in 1888. The economy failed nationwide in the "Panic of '93," and perhaps this was the reason that IXL went bankrupt in 1896. But Cowell, and Holmes, survived.

The turn of the century was also a turning point for the Santa Cruz lime industry --- 1900 was a very interesting year!

A report that the Holmes Lime Company was building a new kiln in Bonny Doon on Ice Cream Grade was released in December of 1899 (see following page). These were called "new kilns." The kilns in Felton are shown as "old Felton kilns" on a 1908 Sanborne insurance map, but the

"old" may refer to "old Felton." With the addition of a railroad depot, the other side of the river had become "new Felton." Henry Cowell purchased the dormant IXL Lime Company in 1900, anonymously through a third party, for $5.00 in back taxes. This included the kilns and a few hundred acres of land. Cowell already owned land adjacent to IXL, to the north up Fall Creek. The author suspects that Cowell was trying to deny IXL a ready supply of fuel! Cowell also began operating the "Bonny Doon kilns" in this year, according to Clark. Cowell had been busy buying land all up and down the coast. His holdings extended from San Luis Obispo in the south to the Vancouver islands in the north. He owned around 12,000 acres in Santa Cruz County alone. As was the case with "Limekiln Beach," our new state park to the south of Big Sur, Cowell bought out companies and closed them down, never operating them himself, but simply getting rid of the competition.

Besides having a half dozen or so lime deposits in Santa Cruz County, Holmes operated a facility in the Tehachapi Mountains. That product was handled by the Union Lime Company of Los Angeles which controlled the southern market. Cowell fought a rate war and managed to keep lime produced by the Roche Harbor Lime Company (the largest on the West Coast) out of the central market by buying up 35% of their stock. Then he announced the purchase of "The Cienega Lime Company" near Tres Pinos in San Benito County. According to the Santa Cruz Surf article of November 17, 1900 (see following page), Cowell had already acquired all the lime properties in the northern part of the state, except for Holmes' holdings. More research is needed to determine what the status of the Davenport properties were at that time. In any event, a conference was called in the office of "Henry Cowell & Co.", with Henry Holmes attending, and a "combine" was formed with the expressed purpose of increasing prices.

It would seem that Cowell truly was the "reputed master of the lime trade." Did he create an alliance with Holmes in order to put pressure on the Davenport interests? We may never know. But Cowell was a shrewd businessman, perhaps a little too shrewd, and he was shot over a boundary dispute shortly thereafter, and died from the wound the following year, in 1903. He did not live to see the rise of "The Santa Cruz Portland Cement Company."

Henry Cowell had seen the industry shift from lime to cement. When his partner, Davis, died in 1888 he had renamed the company "The Henry Cowell Lime & Cement Company." Cowell established a trade in cement with Belgium. Perhaps his ships returned to Santa Cruz with firebrick made in Belgium?

Perhaps because of Cowell's bad reputation with the city of Santa Cruz, a competitive project was considered. William J. Dingee, known as the "cement king," was looking at a site within the city limits as early as 1903. The story of how he opened "The Santa Cruz Portland Cement Company" in 1905, in Davenport, is well documented by Orlando.

Other forces were at work tearing apart the empires of Henry Holmes and Henry Cowell. The continuous burning kilns that were more labor efficient did not work well with the high grade ore of the Santa Cruz Mountains. They were prone to jam which required cooling down and cleaning out the kiln. This may be the reason that Holmes built the old style pot kilns at Laguna,

or it may have been more practical to construct these at the remote site rather than haul in a "patent kiln." Also, the supply of wood for fuel was at an end. Cowell installed an oil burning kiln (the square structure at the UCSC campus gate kilns) which proved too costly due to the distance from the railroad. His son later built four oil burning continuous kilns at Rincon, in 1906 or 1908, along the railroad his father had fought to stop. These kilns did not work well, and three oil burning pot kilns (which appear in photographs to be constructed of concrete) were added in 1920. They selected the proper ore for burning in each type.

The Laguna limekilns were certainly affected by all of this. In addition, transportation costs for shipping barrels and lime over Ben Lomond Mountain to the railhead in Felton must have been excessive. The kilns did not operate for very long. Ruth Adams Trotts told of her uncle and father hauling wood to the Laguna and Felton kilns. Ernest Wildhagen tells of seeing the incline railroad ore cars operating above Felton, but how, when he walked down Ice Cream Grade in 1912, "everything was dead by then."

By 1921, "The W.T. Holmes Lime Company" became “The Holmes Lime and Cement Company." Holmes operated oil burning continuous kilns in Felton, on a railroad siding. The industry shifted to areas with lower grade of ore and easier access to fuel oil. The industry was also shifting to P.C.C., Portland cement concrete. The need for aggregates for the concrete was met in Davenport where shale deposits were in close proximity to the limestone.

There had been a leveling off of the demand for "building quality" lime which was sustained by the need to rebuild after the 1906 San Francisco earthquake. The Holmes Lime and Cement Company continued producing lime in Felton into the 1930s, while the Henry Cowell Lime and Cement Company operated IXL until 1919 and Rincon into the 1940s.

The Bonny Doon Kilns

Two known limekiln sites in the area have been referred to as "the Bonny Doon kilns." One (the subject of this report) is located on upper Laguna Creek, and has also been identified as "Laguna kilns" and "Grove Adams' kilns." The other is on the upper east branch of Liddell Creek (presently the RMC Lonestar quarry), and has also been referred to as "Glassell's kilns," "Jacob lime kilns," and "Cowell's old lime kilns." A review of the historic record and subsequent writings accumulated to date reveals that some confusion, and contradictions exist. This discussion is presented in the hope of resolving this problem, or at least calling the matter to the attention of future researchers.

To further confuse this situation, a three pot kiln with four arches per kiln was reported to have been buried on the lands of RMC Lonestar, approximately west of Thayer Drive, but this has not been confirmed. Also, a story persists that there are kiln remains east of the wine tasting room (formerly "The Lost Weekend" saloon) on Bonny Doon Road. The use of that road name to designate different roads may also have contributed to the confusion and is discussed separately under "The Roads of Bonny Doon" [Local History Article AR-015].

The kiln site on the east branch of Liddell Creek lies to the east of the old Bonny Doon Road, which was abandoned by the county when the by-pass road was built. Its proximity to the uphill landmark, "The Lost Weekend" saloon, may account for the story of a kiln there. A hillside, two-pot kiln with three arches per pot was identified by map, dimensions, and photograph by Ken Jensen as being that owned by Andrew Glassell at this site. It was reported by Jensen that Mr. Glassell "began producing lime in 1858 and used an excellent road to ship his lime to William's Landing on the ocean at the mouth of Liddell Creek." Then in 1867 he took on three partners from San Francisco: Grove Adams, B.F. Lee, and Peregrine Fitzhugh, and they "built two new kilns and a cooperage."

In an interview last year Jensen stated that he concluded that these two new kilns were the side-by-side kilns located on Ice Cream Grade at Laguna Creek. He had no other information about the Laguna kilns. Also he was unaware that Liddell Creek had two other separate kilns as reported by Mike Luther, in 1987, when he surveyed the site at the time RMC Lonestar's main quarry was advancing to the west and the kilns had to be demolished (see map & drawings in appendix B [not included here]). Jensen agreed that the "two new kilns" referred to could have been the two side-by-side kilns he identified as "Glassell's original kilns," while the two separate kilns were actually Glassel's original kilns.

Jensen further concluded that Adams' Road (the precursor of Ice Cream Grade) was therefore named after Grove Adams. Don Clark in "Santa Cruz County Place Names" references Jensen's Adams kilns under "Adams Creek" and states that "Samuel Adams also gave his name to the road now known as Ice Cream Grade." This Adams, probably not even related to Grove, built the limekilns that Henry Cowell bought out which are located on what is now the Grey Whale Ranch. A separate discussion on Adams' Road shows that one P.R. Adams petitioned for the road and that it was more than likely named after him.

Jensen goes on to say that Grove Adams bought out his partners in 1869 and sold Glassell's "original" (?) kilns, in 1872, to a Mr. Boomer and a Col. Payne. They built a new road with a bridge to take their lime to Davenport Wharf, which was a better facility than William's Landing, but are not heard of again. In his map legend Jensen states these kilns were "later owned by Cowell." In an 1884 petition to the county to make Limekiln Road (AKA Coast Grade, Liddell Creek Road, and Bonny Doon Road) a county maintained road this site is referred to as "Jacob" lime kilns, and the existing county road from Empire Grade (built in 1872) to these kilns as "crossing the lands of Jacob." No mention made as to whether the kilns were being operated. A 1905 Bonny Doon parcel owners map shows Henry Cowell as owner of the property where these kilns are located. Maps A4-157 (undated) and A80-222 (dated 22 June 1911) note this site as "Cowell's old lime kilns." These petitions and maps are presented in appendix B. [Not included here.]

Clark describes the "Bonny Doon kilns" as "limestone kilns owned by the Henry Cowell Lime & Cement Company located near the southern intersection of Bonny Doon and Pine Flat Roads. They opened in 1900 and operated only a short time. Named for the district." All of this may never be unraveled. More research is needed to determine the history of ownership of the

Laguna kilns property, but considering that the petition to construct Ice Cream Grade was dated 1893 and signed by P.R. Adams, it seems reasonable that these kilns were not the ones operated by Grove Adams.

Subsequently an item was found in the Santa Cruz Surf, Dec. 11, 1899: "The Holme Lime Company are building a new kiln on the 'Ice Cream' Grade at Bonny Doon." Several references are made to "the Bonny Doon kilns" by Felton writers when reporting about these Holmes' kilns. Edith Fikes, Felton librarian, noted that the Holmes Lime Company referred to their new kilns on Ice Cream Grade as "new kilns." She said they were located "on the coast side of Bonny Doon Road." This is not the same Bonny Doon Road as we know it now! To the folks in Felton, the road we now call "Felton-Empire Road" was the "Bonny Doon Road." See further discussion under "The Roads of Bonny Doon" [Local History Article AR-015].

Quarries, Tramways, Pulley & A-Frames

On the east side of Laguna Creek, downstream of Ice Cream Grade, are two side-by-side hillside pot kilns. Their floor elevation is at approximately 1450'.The creek sides and hillsides are vegetated with second-growth mixed-evergreen forest, which disguises the fact that this was once a bustling canyon with several quarries providing ore to the limekilns. It is not possible to see the quarries from the kiln site. The floors of the large quarries to the south (downstream) are 30' and 80' above the kiln floors. Quarry tailings were dumped on the west-facing slope on Laguna Creek below these two large pits. Five smaller quarry pits are located up the ridgeline above the large quarries. There are also five pits upstream of the site on the unnamed creek to the east; two on the north side and three on the south side. The north-side pits are below the narrow one-lane section of Ice Cream Grade. Reference should be made to the site plan presented in appendix B and the photographs in appendix C. [Not included here.]

Several other limestone quarry sites in the Santa Cruz Mountains have evidence of drilling and blasting. Either drill holes are evident and/or powder magazines have been found nearby. Neither has been found at the Laguna quarries, except for one hole in a kiln lintel stone. Since the deposit is so fractured, it is presumed that ore was removed by the use of pry bars, wedges, and sledges, and if black blasting powder was used it was packed into the existing fractures.

The upper quarry has a section of two-foot gauge rails protruding from the limestone rubble. This is a prefabricated section that used metal ties and narrow-gauge sized rails (2" base x 2 ½" height). It could be readily moved and was therefore used in many quarries where the desired location would change as the ore was blasted off the face and removed. The track appears to align with a ridge connecting the upper quarry with the lower. There may be a depression in the ridge where track was laid or a chute built, but there is no evidence of either and erosion of this slope makes it difficult to interpret. However, if there was a chute, that would mean that the ore had to be reloaded and then carted to the kiln from the lower quarry floor. This would not be very efficient. Of course a chute could be made to dump directly into a car, but there is no evidence of any such structure. If track was laid such that an ore car could be lowered to the lower quarry and then moved to the kiln, that might be more efficient. But that method would

require a brake drum and a cable to restrain the loaded car as it was lowered down the grade of 50' vertical drop in approximately 100' horizontal distance. Since there is no evidence of a brake drum, it may remain a mystery as to how this work was actually done.

There are two small pits on the ridgeline above these large quarries which appear to have had outcropping boulders removed. These may have been probes made to determine the extent of the deposits. The upper quarry extends into the mountain to the southeast. There is not any limestone quarry face in that direction. Either the outcropping was removed and ran out, or a probe in that direction to find more was unsuccessful. The extant face is not that high or wide to look encouraging to an operator hoping that the whole mountain was limestone!

Much the same can be said of the lower quarry. The vein seems to have sloped up the hillside and the quarry "floor" sloped upward with it. There is a rock wall built to provide a flat work area at the base of the face. The vertical veins are mixed limestone, quartzite, and metamorphic sandstone with some deep red schist. Flowstone coats some of the fracture surfaces (see "Geology").

The lower quarry has a grade cut for a tramway and a creek crossing to the kilns. Several ties with spike holes from two-foot gauge rails were found on this grade and on the lower quarry floor. None showed wear due to animal use. When animals (horses, mules, or oxen) were used, either to brake the load or pull the empty car back up the grade, the ties became "scalloped" between the rails. There are some structural remains (a beam and a 10' plank) in the creekbed, but not enough to ascertain whether the tracks crossed a bridge. This would seem desirable, as the span and the slope of this structure would not be conducive to using a gravity chute to transport the ore across the creek. However, there is not any ramp built up on the kiln side of the creek for tracks to transition onto the flat. The questions regarding this detail may never be answered.

An earlier grade from the lower quarry went up the side-canyon to the east (see site plan) and gets lost in the rubble of the intermittent creek bed and the floor of the quarry located there. It must have been used prior to the bridging structure as that cut is lower in elevation and cuts through the original grade. It is likely that it crossed the creek. Perhaps a spur and switch, or a turntable, was necessary as the space available was too narrow to allow use of a hairpin curve.

A three-foot gauge tramway was uncovered at the top of the kilns. It was buried beneath the hard pack surface of the loop road. It ran parallel to and 4 ½' from the back wall of the kilns. One 24' section of narrow gauge rail curves to the east towards the quarries that are up the side-canyon (see drawing in appendix B [not included on this site]). It is possible that larger cars were used to bring the limestone blocks, used to construct the kilns, down from these quarries. They may have continued using this tramway to transport ore, or they abandoned it. More work needs to be done with metal detectors to locate other rail sections or spikes.

A large cast iron 6 ½' diameter pulley is located 85' above the top of the kilns to the east of the lower quarry. This sits on an earthen platform, retained with a 6' stone wall, overlooking a cut

on the hillside which was made to provide clearance for the hanging ore cars. Mortar is not evident in the wall. The pulley was most likely brought down to the site from upper Ice Cream Grade. The structure that the wheel was mounted on is missing, or may have never been completed. Although there are two wooden footings, nominally 8" x 5" x 7 foot redwood, there are no other beams or any obvious evidence of fire. The bolts, nuts, and washers on the axle bearing mounts do not have any wood attached. These bearings are cast and have babbit metal bearing surfaces. One is 8" long and is cast with raised letters identifying the manufacturer as "Vulcan Iron Works SF Cal" and "2 ¾" designating the diameter of the pulley shaft. The shaft is 11" long on this end. The pulley hub is 7" wide and the shaft is stepped to 3" diameter and is 25" long on that end. The bearing there is 8 ½" long and is a thrust bearing, indicating that the wheel may have been mounted horizontally, with the shaft vertical or at an angle from vertical. The six-spoked pulley has a 4" rim, 2 ½" thick with a 3 ¾" flange, and a 6" diameter hub. The base of the flange opening has a ¾" diameter woven fabric material which may have absorbed a lubricant for the cable and is still intact after many years of exposure. No seam can be detected in this material, and it is not known how it was installed. Although no aerial cable (called "wire rope" at the time) has been found, it was most likely 1 to 1 ½" diameter.

Galvanized, 1" diameter anchor cables and a small quarry pit are uphill of the pulley. These cables have six strands of seven strand wire sub-cables wrapped around a three strand rope core. The four anchor cables were each cut through, apparently with a hacksaw, at the loop made by the extant cast cable clamps (see photograph [not included on this site]). There is also a U-clamp on each assembly. Continuity tests were made using a volt-ohmeter to see if the cable sets could be determined. It is felt that either the left and right cables are one, or the inner and outer cables are one. Due to the damp conditions, continuity existed across all legs of the cables and across the earth from one side to the other, and the configuration could not be determined. These cables are most likely wrapped around a log which was buried under a pile of rocks to make a "dead man" to counter the weight of a loaded ore car. They have a spread of 5 ½' compared to the shaft length of 43". The cut cables indicate that there was some other load bearing device (perhaps another cable loop, or a metal strap) which had been in place but was removed. The inside surfaces of the loops seem to be flattened from loads applied during use of the aerial tramway. It seems likely that the cables would not have been cut if the wheel was being removed by the company at the end of operations. In that case they probably would have disassembled the anchor pile and deadman, and unbolted the cable clamps. The fact that the cables were cut may be evidence that an attempt was made scavenge the wheel. Scrap metal drives during the Second World War stripped many of the industrial sites in the Santa Cruz Mountains. Many artifacts were also lost in the 1960s when a frenzy of nostalgia hit this country.

The metal parts found near the wheel are the 2" wide brake band from the 43" diameter brake (cast into the wheel) used to control the descent of the ore car. It is probable that the loaded car, descending by gravity, pulled an empty car back up. The exact configuration of this installation is not known since the pulley mounting structure is missing. It is possible that there were other smaller pulleys used to control the runoff of the cable (similar to ski-lifts seen

today), but that these are missing also. Gravity-powered aerial tramways were considered a very economical means of transport.

A bearing 90 degrees to the center of the retaining wall sights down to the two A-frame structures found at the top of the left kiln. These are located on the north side of the kilns and are on the uphill side of the loop road. They were set 5' apart at the base and appear to be pushed over by slide material coming down from Ice Cream Grade. There is some remaining structure aligned opposite the frames (and downhill of the loop road) with dimensions similar to the 6' spread of the frame legs, but it is not known if they are part of a single installation. The frames are bolted at the apex of two 13 ½' long redwood poles resulting in about a 27 degree angle. The diameters of the poles facing the pulley are smaller than the others --- 8" and 12" for the right frame, and 5" and 10" for the left. The bolt on the right hand frame is slightly different from that on the left hand frame for reasons unknown. The cross braces are 4' long, ¾" diameter iron rods, each threaded and bolted on each end.

It is not certain that the A-frames actually were the downhill end of the aerial tramway. The alignment may be coincidental. If they were, they would have had to have been anchored someway to take the load of the ore car (or cars, or buckets) hanging from the cable. There is no evidence that this was done --- no cables, no deadmen, and no cable marks on nearby trees. Also, if the pulley was mounted horizontally (which is the best arrangement for handling and loading a two car system) the question arises as to how a pulley would have been mounted on the A-frames. Although no cable or ore cars were found, it seems reasonable that an aerial tramway was used at some point of the operation, and that the A-frames may have been part of the downhill anchor point.

Again, the quarry pit behind the pulley extends into the mountain to the south. There is no large quarry face. Veins of limestone and quartzite appear on the east side of the quarry "gate." The small pit above this quarry may also have been a probe to ascertain the extent of the deposit and may also have given the operator false hope. Perhaps the successful experiences of the Holmes Lime Company in their quarries on the Felton side of Ben Lomond Mountain also helped to mislead them?

There was another small quarry pit reported west of the kiln site off of Ice Cream Grade on what were the lands of Walter Mahan (see oral interview #1 in the bibliography). Ore is said to have been delivered to the Laguna kilns from this pit. Ore brought to the site by wagon could be unloaded into the top of the kiln. Traffic would be clockwise around the kilns as loaded wagons would go up the long ramp, and empties would go down the short ramp.

Judging from the sizes of the kilns and the quarries, not too many loads were burned. Further work could be done to calculate the volume of ore removed for burning. This is the volume of the quarry hole less the volume of the tailings. To estimate the total production of the facility in terms of total number of loads burned, the volume of ore mined can be divided by the volume of ore needed to load a kiln. To calculate this, the total volume of the kiln pots must be adjusted by the volume of the fire chamber inside each arch, and the voids between the chunks

of limestone. Unfortunately, the number of years that the kilns may have operated cannot be estimated unless more facts are known or more assumptions are made. The loads burned per year might be a function of many variables, including the length of the rain season and whether the kilns operated over consecutive years.

More research is needed to determine when the track section, pulley, anchor cable, and clamps were manufactured. Most likely both were "off-the-shelf" items that were advertised in the industrial or mining equipment catalogs of the day. Such catalogs are available to researchers. However, like with bricks, this equipment could have been purchased before or after construction of the kilns and knowing when they were manufactured does not necessarily fix that date.

On the ridge line between the two small pits above the upper quarry there is a power pole. Some wire with weathered insulation is dangling, but the insulators that would be on the pole have been removed. The pole is creosote soaked and has a round metal tag attached which says "Osmoplastic Dan Kamp-Ausen Co." around the edge and the number "62"in the center. No other poles have been located, either uphill or across the canyon, so it is not known whether this line brought power to the site or was routed to Bonny Doon. It is possible that the number stands for 1962.

There are at least ten quarry sites where blasting took place on Ben Lomond Mountain, five above Felton and five in Bonny Doon. This mountain has another name whose origins are obscure: "Battle Mountain." In addition to the stories told by Clark, some locals talk of the limestone and sandstone rocks, like "Bald Mountain" on Smith Grade and the "moon rocks" on Martin Road invoking the image of battles waged on these fortresses, while others reflect on unremembered family feuds and road access struggles. The author favors the blasting at so many quarries as being the reason! The battle-like rumble can still be experienced.

Ernest Wildhagen claims that the county closed down the Laguna limekilns because the blasting in the quarry threw rocks onto Ice Cream Grade, and that, with the noise, scared the horses that were pulling wagons and it was too dangerous. Perhaps so. As always, more research is needed.

Kiln Construction

Since ancient times, limestone has been burned (calcined) in open pits or piles with the fuel mixed or layered with the ore. Mud, or clay, was sometimes plastered on the outside to help contain the heat. Ventilation is needed to bring oxygen to the fuel and to remove the carbon dioxide and water vapor that is released. Draft holes around the bottom and an open top provided airflow. The next step was to line the pit with rocks to reflect the heat. This method is referred to as a "single chamber kiln." Such a kiln had to be loaded with a proper amount of fuel, since there was no way to add any, and the ashes ended up being mixed with the lime. It is better to keep them separated to prevent this from happening, and so the "double chamber kiln" came into use. Another advantage to this design is that fuel can be added as needed.

Separation has been accomplished by various means -- rock or metal grates being the most common.

The second chamber (or firebox) was created by constructing a tunnel in the limestone as it was loaded into the kiln. This was done by the "archer," who piled the limestone ore to form an arched tunnel from the front access door to the rear wall of the kiln. The surface of the tunnel acts as a grate if voids are provided for the flames to pass through. The kiln is in effect an updraft furnace or oven. A rock grate can be the ore itself, but when limestone calcines, it tends to crumble. The higher the grade of ore the more it does, so low grade ore was used to build the arch. Such crumbling is disastrous if it causes the arch to collapse. After the fuel burns out and the load cools off, the kiln must be emptied, repaired (if needed), and reloaded.

To provide access to the fuel chambers, openings were constructed through the lower part of the kiln wall. The kiln was either built free-standing or into a hillside with the downhill wall exposed. The latter method was easier to construct as the earth supports three of the walls, the back and sides. The front wall was therefore usually thicker and was buttressed. The shape of the kiln varies from circular to rectangular or oblong. The walls may be straight or flared (top opening area is less than the kiln floor area) and the corners may be squared or rounded. Flared kilns with rounded corners resemble a pot and are known as "pot kilns." This construction is the most efficient as the heat is reflected inward and distributed evenly. There is less chance of the limestone being overburned or underburned. Overburned ore was not used by lime producers on the West Coast, but was used in England to make a special cement. Underburned ore can be reloaded, but time, manpower, and fuel is wasted.

Loading was done from the top with the ore placed from bottom to top. Unloading was done from both the top and through the access doors at the bottom.

With larger kilns, more fire chambers were needed to provide even heating. Therefore more arches were required in the front wall, resulting in a greater span between the buttress walls. Single, double, and triple arch kilns were built. The larger producers all used kilns with four arches and these were constructed with three kilns to a facility.

Some kilns had a roof over the work area in front of the access doors. This protected the lime from the rain when the kiln was unloaded and placed in barrels. Quicklime is very unstable and becomes hydrated when water is added. Rain falling on the open top was also a problem. Wet fuel and muddy, impassable roads were other reasons that lime production ceased during the winter months.

The purer the limestone, the higher the temperature needed to burn it. The lowest temperature that pure calcium carbonate will calcine is 1648 degrees F (900 degrees C). Kilns were usually fired around 2200 degrees F. The draft was regulated by lying flat pieces of limestone or sheet metal over the top. Metal doors were also used on later kilns.

The temperatures and pressures involved put great stress on the walls, especially the front wall, which did not have the earth to help support the outward thrust of the loaded ore. In addition, if the wall was constructed of limestone, it also would turn to lime which weakens the wall and becomes a problem the older the kiln gets. The arches in the thick front wall tend to trap the heat and are especially vulnerable. Therefore, firebricks were used to line the arches and the kiln walls, and were often double layered. Regular building bricks vitrify (deform and turn glassy black) at these high temperatures and do not make as good a lining as firebricks. Metal arch inserts were also used and have been found at two sites. These are either forged or cast iron. A lining, made of firebrick with refractory mortar, not only reflected the heat but kept the quicklime from adhering to the wall, making unloading easier. When used on the fire chamber floor, it also provided a surface which made it easier to shovel away the ashes.

Even thick front walls were subject to cracking and bowing, and one kiln at Grey Whale Ranch has a collapsed front wall. These failures were sometimes prevented or reduced by adding shoring or by buttressing the wall. Many kilns were constructed with built-in (integral) buttress walls. At several sites log shoring and/or stone walls were added in three places (between each arch) as the wall weakened with age, and at one a stone buttress wall was added to the original structure.

A single-pot kiln does not use labor effectively. Loading, burning, cooling, unloading, and repairing are the steps for manufacturing quicklime from limestone, and with a single kiln these steps must be done in sequence. A double-pot (side-by-side kilns) allows the crew to load and unload a kiln while the other kiln is burning or cooling. Adding a third pot enables a crew to always be unloading one kiln, while another crew is always loading a second, and the stokers are always tending the fire in the third. With this specialization, two stokers each worked a 12-hour shift providing around the clock burning. When one load was done "cooking," the next load would be ready to start and so they moved from one kiln to the next. A work cycle for one kiln varied but generally it took 1 to 2 days for loading, 3 to 5 for burning, 2 for cooling, and 2 for unloading. A day or two was usually needed for repairs on the fire mortar or brick lining on the inner walls. Thus a burn averaged 9 to 13 days. Loading or unloading a larger kiln took more men, not more time.

Firebricks

The presence or absence of firebricks at an industrial site, and the names found on these bricks, is revealing. Several shapes of firebrick (regular, arch, and wedge), and many different named brick, were found at the Laguna limekilns. Most of these were probably imported. Some of these have also been found at other sites in the Santa Cruz Mountains, but three are unique to this site. Of those, one has never been reported before!

The practice of stamping, or "branding," the manufacturer's name on a brick goes back to ancient times and was still in vogue at the time these kilns were operating. There are currently only one or two brickmakers in the United States that stamp their name in their brick. The

introduction of high speed brickmaking machines made this impractical. Most of the industry stopped this practice forty to fifty years ago as it was an unnecessary, time consuming step.

Fireclay was found in shallow pits and used to make crucibles as early as the 1700s in Europe. The Industrial Revolution brought about the demand for high quality refractory bricks as new equipment and systems were developed. The demand for coal also increased and high grade coal had to be mined at greater depths. It is ironic that the best fireclay was found in conjunction with these deep coal deposits.

The early Spanish and Mexican kilns probably did not utilize firebricks. Most likely they were first imported sometime after 1850. From the early 1850s to the late 1870s firebricks had to be imported to California. At first, the only sources were Scotland and England. A unique find at the Laguna kilns revealed that Belgium also provided bricks. Firebricks (also called refractory, or kiln bricks) were made of higher density clay which was sometimes pressed to remove air and water, enabling the brick to withstand high temperatures. Common building bricks were used on occasion, but these could not hold up as well to high temperatures. Vitrified common and firebricks have been found melted, blackened, and glazed at several kiln sites. Firebricks were made in Europe and shipped (as ballast) "around the horn." At ten cents a brick delivered, the brickyards of the mid-west could not compete. The cost of hauling brick overland was prohibitive. Eventually good quality clay was located in California, but it was not until after the 1910s that production exceeded imports. With the threat to shipping during world war I all imports ceased and were never needed again after the war as the country had become self-sufficient.

As the industries on the West Coast developed, steam became an important energy source. This, in turn, was generated in boilers by burning wood fuel. In the Santa Cruz Mountains redwood was the preferred fuel as it burned hot, slow and steady. "Pine" (actually fir), oak, and madrone were also used. Railroad locomotives, "donkey" engines, steam schooners, loading chutes, and even the fog horn at Pigeon Point Lighthouse were steam-powered. With steam power the brick lining the fireboxes of the boilers required frequent replacement. Although such equipment was used in the Santa Cruz Mountains, most of the firebricks are found at limekiln sites. In the early 1900s firebricks were also used to line local sawmill incinerators and fireboxes of boilers at the canneries and food processing plants.

Besides being used for lime production, kilns were also used for brickmaking, lumber drying, and hop and apple drying. The arches of field kilns used for making brick were often lined with firebrick as this location got exceedingly hot. The other types of kilns did not get hot enough to warrant the use of firebrick. But limekilns generated high temperatures (up to 2200 degrees Fahrenheit) to convert the limestone ore into lime, and since the "kills" themselves were made out of limestone the walls had to be shielded to keep them from "cooking" into lime and crumbling!

Stamping names on bricks was a matter of pride or politics, but it also created a depression which would not only save the brickmaker material and make the brick lighter weight, but

provided a "key" for the mortar to penetrate. Thus, when the mortar hardened the upper and lower bricks were interlocked. Most of the brick found at the Laguna limekilns are hand-stamped. This is the reason that the name appears at different locations on the surface of the brick, and that the "b" in Snowball was found rotated in two bricks.

Some names set within a depressed frame, called a "frog," had either depressed or raised letters. The frogs had various shapes: rectangles, rectangles with scalloped corners, diamonds, triangles, circles, eyes, and various other shapes. Some frogs also had beveled or curved edges. A brick with a frog would also require less heat to harden it, therefore resulting in a savings of fuel in its manufacture. Also, less weight meant lower shipping costs.

In 1891 Congress passed the "McKinley Tariff Act" which required that imported products be identified as to their country of origin. This may have caused some brickmakers to stamp their names and countries in their brick, but others may have already been doing it out of pride. Regardless of the reason, an evaluation of the bricks found at a site can be helpful in dating the site and establishing the flow of goods.

Firebricks found in limekilns are usually used as a lining and are therefore not an integral part of the structure. Finding a particular named-brick doesn't necessarily date the site. It only provides a possible date that the brick itself may have arrived on the scene. Knowing when a brickyard started using a name might be helpful, but the age of the structure could be older than the brick if the brick was brought in at a later date to line an existing structure. Conversely, finding an old brick at a site does not preclude the possibility that a brick was imported at an earlier time, before the kiln was built, and reused subsequently at the time the lining was last installed. Knowing when a brickyard stopped using a name (or went out of business entirely), reveals the minimum age of the brick, not the structure.

Or, as more aptly stated in "Brick Bats for Archaeologists: Values of Pressed Brick Brands," by Roger and Marsha Kelly: ".... Reuse of bricks is an important capability which may lead to ambiguous interpretations of chronology ..."

Bricks come in all different shapes, sizes, and colors. Shapes vary from cylindrical, square and triangular, to the rectangular ones we see most frequently. Sizes vary as shrinkage of the clay, while it is burning in a brick kiln, is difficult to control. Also, originally there were no standards for size, but common building brick tended to be smaller than firebrick. Generally the firebrick imported to Santa Cruz was 4 ½" wide x 9" long x 2 ½" thick. (The newer ones found here are a little smaller: 4" x 8 ¼" x 2 ½".) The common vary from: 4" x 8" x 2 ½" to: 4 ⅛ x 8 ½" x 2 ⅜. Firebrick is seldom, if ever, red like common building brick. Iron in the clay turns these brick red when they are burned in the brick kiln. Since fireclay is different, the firebricks come out yellow to beige, and darker brown to light grey colors.

Calder
Brickmaker: Robert Flemming & Co., "Calder Fire Clay Co."
Location: Calder, Coatbridge, Scotland
Dates: Ca. 1890-1937
Comments: Noted in Kelly's Directories Ltd. 1931 & 37
Several pieces were found at the Laguna kilns. Then whole brick were discovered in the fire chamber floors.

Carr
Brickmaker: John Carr & Sons
Location: Low Lights, North Shields, England
Dates: Ca. 1844-1908
Comments: Began making firebricks by 1889 at the latest.
Noted in Kelly's Directories Ltd. 1908.
This brick is difficult to identify, as it may be confused with the T Carr brick, especially when only a partial brick is found as was the case at the Laguna limekilns.

Cowen
Brickmaker: Joseph Cowen & Co.
May have originally been Foster & Cowen.
Location: Blaydon-on-Tyne, England
Dates: Ca. 1823-1904
Comments: Brand registered with United States Patent Office 1893. Take-over firm operated to 1946. The most common firebrick (found at six sites) in the Santa Cruz mountains. Known to be stamped with grade (?) numbers up to 6 above, below, or to the side of the name. Also found arch and wedge shaped, and stamped "Cowen/England."

Foster
Brickmaker: Henry Foster & Co., Ltd.
Location: Newcastle-on-Tyne, England
Dates: Ca. 1890-1963
Comments: Noted in Kelly's Directories Ltd. 1963.
May have been the same Foster said to have started with Cowen. Also reported in IBCA's Journal of Fall 1990 as being made at a brickworks in Belleville, Ontario, Canada (east of Toronto).

LAPBCo/***
Brickmaker: Los Angeles Pressed Brick Co.
Location: Los Angeles, California
Dates: 1887-1926
Comments: This company is said to have had a plant in Richmond, California. Bricks found in Santa Cruz may have been made in Richmond.

Ls Escoyez / Tertre / Belgique
Brickmaker: [Jean-Henry Escoyez, who lives in Belgium, sent the following information to the Library in August 2000: "'Ls' isn't the abbreviation for the French word 'Les', but it is the abbreviation for the first name 'Louis', who was the founder of this factory, and the mayor of the village Tertre, in Belgium. Now this factory is closed, but I don't know when. (Probably after the World War I).Tertre is a village in the county of Saint-Ghislain, province Hainault, near the town Mons (Chief town of the province), and more or less 60 km (50 miles) of Brussels.]
Dates: Unknown
Comments: Several fragments of this brick and two overlapping brickbats have been found at the Laguna limekilns. This is the only site where this item has been found to date. As far as is known, it has never been reported before!

Pacific
Brickmaker: Not known.
Location: Probably originally made in England for the Pacific Northwest trade.
Dates: Probably the mid-1800s.
Comments: Later use of this name by the Gladding McBean Company also had their logo, GMcB, on the brick above or below the name. Also found wedge shape.

Patent/R Brown & Son/Paisley and
Patent/R.Brown & Son Ltd/Paisley
Brickmaker: Robert Brown & Sons, Ltd.
Location: Paisley, Renfrewshire, Scotland
Dates: Ca. 1836 - 1938
Comments: Started making firebrick in 1852. Became "Limited" in 1902. Several pieces of this brick have been found in various places in Santa Cruz County, but only one piece with Ltd was found and that was at the Laguna kilns. The word "patent" means that the method or formula for making this brick was patented.

Ramsay
Brickmaker: G.H. Ramsay & Co.
Location: Newcastle-on-Tyne, England
Dates: Ca. 1789-1925
Comments: Kelly's Directories Ltd. 1925
Only one large partial piece of this brick was found at Laguna kilns, and this occurred on the last day of the survey!

Ravens/W B I & Co.
Brickmaker: Unknown
Location: Unknown
Dates: Unknown
Comments: Fragments have been found at two kiln sites. Whole bricks without any mortar attached have been found at two residential locations in Bonny Doon; two as pier blocks, and

ten lining a barbecue. Fragments were found in an old dump in Bonny Doon. At the Laguna limekilns it is found more frequently than any other brick.

RBC
Brickmaker: Unknown. May be Richmond Brick Co.? Brick is known to have been made at Point Richmond, with the name "Richmond" by United Materials Co. from 1927 to 1930.
Location: Unknown
Dates: Unknown
Comments: Only one brick with these letters was found at the Laguna limekilns. The only other ones found in Santa Cruz were the two buried in the yard at the old Majors Creek ranch house on Empire Grade in Bonny Doon.

Snowball
Brickmaker: James and George H. Snowball
Became Snowball Brothers Ca. 1913
Location: Swalwell, County Durham, England
Dates: Ca. 1854-1935
Comments: Several letter sizes and styles are known. Also comes in arch and wedge shapes. Noted in Kelly's Directories Ltd. 1935. Have been found at five limekiln sites in Santa Cruz. Two fragments of this brick having a backward "b" (i.e. rotated) were found at the Laguna limekilns.

T Carr
Brickmaker: Thomas Carr & Son
Location: Newcastle-on-Tyne, England
Dates: Ca. 1827-1918
Comments: Noted in Kelly's Directories Ltd. 1901 & 1918.
Also found in arch and wedge shapes.

The Bricks of Santa Cruz County

Named or branded bricks as seen, photographed, and/or collected in Santa Cruz, California from 1975 to 1996. List revised 17 September 1996.

Alumex
Alusite / 114 132
Amador
A P Green
A.P.Green / Empire S.M
A.P.Green / Empire D.P.
A.P.Green / 2K S.M
A.P.Green / 3K S.N (may have been M?)
Arco (may have been Argo?)
Aztex / 120(--?--)

- B - (small letter, in 3/4" x 1 3/4" frog, dash = screwhead)
Benson
Bourtreehill / Irvine
Calder
Cardowan / Patent
Carnegie (also key brick)
Carnegie / 2
Carnegie / 3 (key brick only)
Cowen
Cowen-M / England
6 / Cowen
Denny Renton (paver)
Dia-D
Diablo
Diablo / 1
Diablo D / 1
Dickey Premier
Dickey Clay Mfg. Co. / Star (see also "Star")
Duro
Empire D.P
Empire S.M
Empire S.M / 13 1/2 2K 2 1/2
Foster
Gartcosh
Gartcraig
Gasco / XX
GMcB (short arc)
GMcB / 6 - 72 (logo of Gladding, McBean and Company)
Heatheryknowe / Patent / Glasgow
Hickman / Stourbridge (stamped on side)
Ione
Jaybee / Fine
Keystone
-L- (for Lincoln, by Gladding, McBean?)
Laclede / Alamo
Laclede / Flintmix
Laclede / Supra 215
Laclede-Christey
LAPBCo / * * * (Los Angeles Pressed Brick Company)
Livermore (stamped in "frog" on middle line)
(see also "Premier / Livermore")
Livermore (stamped on upper line)
Livermore *
* / Livermore

Livermore / *
Livermore F.B. Wks. SF
Ls Escoyez / Tertre / Belgique (French for Belgium)
Mex-Ref-Co / Aztex
M.T & Co (only one period)
No 1 Wedge
No 1 Wedge / F
Oakland
Pacific
Patent / R.Brown & Son / Paisley
Premier
Premier / Dickey Clay Mfg. Co.
Premier / Livermore
Premier / Livermore F.B. Wks. SF
Ramsay
Ravens / WBI & Co
RBC
Richmond
Richmond (RL)
Snowball (also wedge and key bricks)
Star
Star / Dickey Clay Mfg. Co.
Stockton
T Carr (also wedge and key bricks)
The Denver / Hifire / Fireclay Co
Walbottle
W.S. Dickey Clay Mfg.Co. / Premier
W.S. Dickey Clay Mfg.Co. / Star / No 1 Arch
Woodland
0 (fine letter in small, shallow frog)
00
-1-
1 3/4
2
2" - Split F
72 81
GM 70 D
-HR SP / 9-
* * * (Gladding, McBean)
Triangle
One Perforation

Notes:

Bold letters indicate "best guess"
/ Indicates new line on the brick
Periods are shown only as they appear on the brick
FB = firebrick, RL = raised letters (otherwise letters are depressed)

Glossary

Arch Brick
Wedge-shaped brick used in building an arch. Usually an arch brick is wedged such that it appears truncated when viewing it from the end. A wedge brick can be truncated when viewing it from the face or side, and either can be used in building an arch.

Bat or Brick Bat
A piece of brick. Usually half a brick containing either the right or left hand end.

Brick
A solid masonry rectangular block made from clay and/or shale and burned (or fired) in a kiln. The plural of brick may be bricks or brick.

Building Lime
A higher grade (or quality) of lime than that used for agriculture, or other uses such as manufacturing paper, paint, or soap; refining sugar; or processing hides for leather.

Common Brick
Any brick designed for building purposes. Usually refers to softer and less expensive bricks.

Firebrick
Brick designed to withstand high temperatures. Made with special fireclays. Most common standard size is 2 1/2" x 4 1/2" x 9" but is produced in various sizes and shapes.

Frog
A depression in the face of the brick made by a panel placed in the bottom of the mold. Lettering is placed on this panel to make either a raised or depressed letter in the frog.

Kiln
An oven-like compartment built to contain the heat around the item to be calcined, cooked, baked, burned, or fired. A "pot" kiln (or field kiln) is usually built with an open top to facilitate loading the kiln. "Patent" kilns were metal designs that were patented, and came ready to assemble. Thomas Bull had one near his pot kiln. Other patent kilns were "continuous," as the limestone moved through the kiln while the fuel (usually oil carried by steam) burned continuously. These were more efficient, but were hard to operate with high grade ore which

crumbled more easily and jammed the kiln. The time saved in reducing the load/unload cycle might be lost when a kiln jammed. Limekilns are like updraft furnaces or ovens. Some sources use the singular, kiln, to denote the site, even though more than one kiln exists. Use of the words "kill," and "kills," may derive from the archaic spelling "killn."

Limestone
Any number of differing ores usually containing 50% or more of calcium carbonate, ($CaCO_3$).

Quicklime
Also called lump lime, caustic lime, or unslaked lime. This was the name given the lime (CaO) as it was removed from the kilns and packed into barrels. It was "quick" to stick to the skin. Handling the product is hazardous, as it is caustic, takes water from the flesh, and gives off heat. This heat is enough to char wood, and warehouses and schooners shipping lime were known to catch fire.

Refractory Mortar
Also called fire mortar. A finely ground refractory material which becomes plastic when mixed with water, and is suitable for use in laying refractory brick (i.e. firebrick).

Slaked Lime
Quicklime has an avidity for water which is added intentionally to hydrate, or slake, the lime causing it to crumble into powder. Slaking quicklime produces CaOH and is the first step in making lime products such as milk lime, whitewash, plaster (lime plaster), stucco, mortar (lime mortar), cement, and concrete. Thus lime that has not been slaked is said to be "unslaked lime." When the water is taken from the atmosphere, it is said to be "air slaked," or "dry slaked." When water is added to hydrate it, it is said to be "wet slaked."

Tufa
Also known as travertine, this rock formation occurs when dissolved calcium carbonate precipitates out of solution. This is similar to the process that creates flowstone, and stalagmites and stalactites.

Vitrification
A condition resulting from kiln temperatures high enough to fuse grains and close the pores of a clay mass, making it impervious to water.

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Source

Excerpted from a manuscript titled, "The Laguna Limekilns: Bonny Doon." The maps, drawings, and photos of the manuscript are not included in this article. The manuscript is copyrighted 1996 by the author. It is used here with permission.